

# Solubility of a Salt

## PRE-LAB DISCUSSION

The solubility of a pure substance in a particular solvent is the quantity of that substance that will dissolve in a given amount of the solvent. Solubility varies with the temperature of the solvent. Thus, solubility must be expressed as quantity of solute per quantity of solvent at a specific temperature. For most ionic solids, especially salts, in water, solubility varies directly with temperature. That is, the higher the temperature of the solvent (water), the more solute (salt) that will dissolve in it.

In this experiment, you will study the solubility of potassium nitrate ( $\text{KNO}_3$ ) in water. You will dissolve different quantities of this salt in a given amount of water at a temperature close to the water's boiling point. Each solution will be observed as it cools, and the temperature at which crystallization of the salt occurs will be noted and recorded. The start of crystallization indicates that the solution has become saturated. At this temperature, the solution contains the maximum quantity of solute that can be dissolved in that amount of solvent.

After solubility data for several different quantities of solute have been collected, the data will be plotted on a graph. A solubility curve for  $\text{KNO}_3$  will be constructed by connecting the plotted points.

## PURPOSE

Collect the experimental data necessary to construct a solubility curve for potassium nitrate ( $\text{KNO}_3$ ) in water.

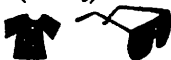
## EQUIPMENT

balance	graduated cylinder, 10-mL
burner	stirring rod
microspatula	ring stand
test tubes, 18x150-mm (4)	iron ring
test tube holder	utility clamp
test tube rack	wire gauze
beaker, 400-mL	marking pencil
thermometer	safety glasses

## MATERIALS

potassium nitrate ( $\text{KNO}_3$ )	distilled water
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## PROCEDURE



While one lab partner carries out the instructions in steps 1 through 4, the other partner should go on to step 5.

- Using a marking pencil, number 4 test tubes 1 through 4, respectively. Place the tubes in a test tube rack.
- On the balance, measure out exactly 2.0 g of potassium nitrate ( $\text{KNO}_3$ ). Pour the salt into test tube # 1.
- Repeat step 2 for the following masses of  $\text{KNO}_3$ . Add each quantity to the test tube indicated:
  - 4.0 g to test tube # 2
  - 6.0 g to test tube # 3
  - 8.0 g to test tube # 4

- Add exactly 5.0 mL distilled water to each test tube.

- Fill a 400-mL beaker about three-fourths full of tap water. This will be used as a water bath. Using the water bath and test tube # 1, prepare the setup shown in Figure 33-1. Heat the water to  $90^\circ\text{C}$  and adjust the flame to maintain the water at about this temperature.

- Stir the  $\text{KNO}_3$ -water mixture with a glass stirring rod until the  $\text{KNO}_3$  is completely dissolved. Remove the stirrer and rinse it off. Loosen the clamp and, using a test tube holder, remove the tube.
- While lab partner number one repeats step 6 for test tube # 2, lab partner number two should place a *warm* thermometer (dipped into the hot-water bath) into the solution in test tube # 1. Hold the test tube up to the light and watch for the first sign of crystallization in the solution. At the *instant* crystallization starts, observe and record the temperature. Should crystallization start too quickly (due to using a cold thermometer), redissolve the solid in the hot-water bath and repeat this step.
- Procedural steps 6 and 7 should be followed for all four test tubes. One lab partner should stir the  $\text{KNO}_3$  until it dissolves, and the other partner should record the temperatures of crystallization. Record all temperatures in your data table.
- If any doubtful results are obtained, the procedure can be repeated by redissolving the salt in the hot-water bath and allowing it to recrystallize.

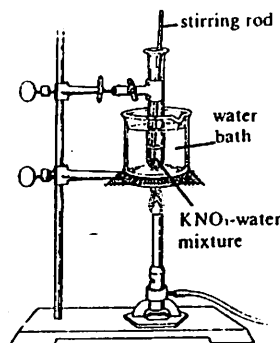


Figure 33-1

## OBSERVATIONS AND DATA

test tube #      grams of  $\text{KNO}_3$ /5.0 mL  $\text{H}_2\text{O}$

crystallization temperature ( $^{\circ}\text{C}$ )

1	2.0 g/5.0 mL
2	4.0 g/5.0 mL
3	6.0 g/5.0 mL
4	8.0 g/5.0 mL

_____
_____
_____
_____

## CALCULATIONS

- Using proportions, convert the experimental mass/volume ratios to equivalent mass/100-mL ratios.

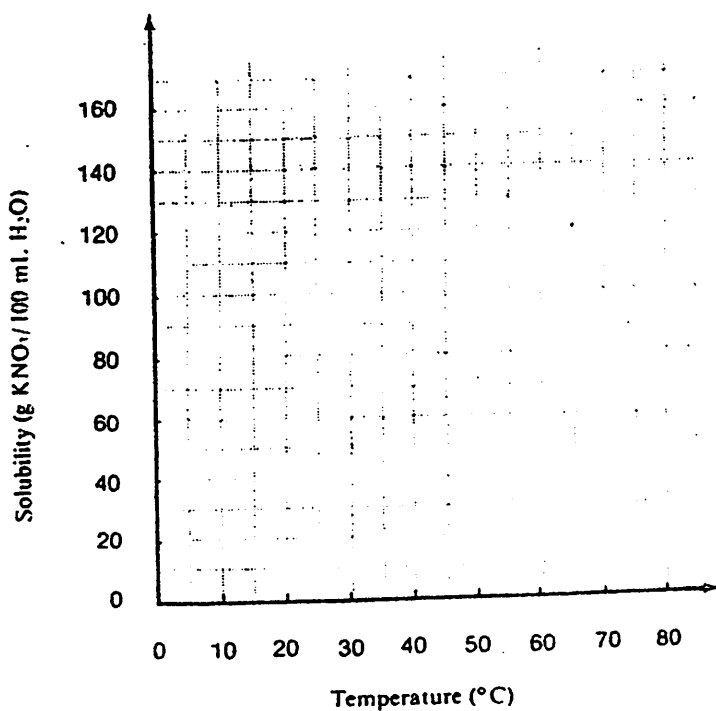
$$2.0 \text{ g}/5.0 \text{ mL} = \text{_____ g}/100 \text{ mL}$$

$$4.0 \text{ g}/5.0 \text{ mL} = \text{_____ g}/100 \text{ mL}$$

$$6.0 \text{ g}/5.0 \text{ mL} = \text{_____ g}/100 \text{ mL}$$

$$8.0 \text{ g}/5.0 \text{ mL} = \text{_____ g}/100 \text{ mL}$$

- Plot your experimental data on the grid provided. Plot mass of solute per 100 mL of water on the y-axis and temperature on the x-axis.



## CONCLUSIONS AND QUESTIONS

- How many grams of  $\text{KNO}_3$  can be dissolved in 100 mL of  $\text{H}_2\text{O}$  at the following temperatures?  
(a)  $30^{\circ}\text{C}$     (b)  $60^{\circ}\text{C}$     (c)  $70^{\circ}\text{C}$
- Define the terms saturated, unsaturated, and supersaturated.
- Classify the following  $\text{KNO}_3$  solutions as saturated, unsaturated, or supersaturated. Explain your answer. (a) 75 g  $\text{KNO}_3$ /100 mL  $\text{H}_2\text{O}$  at  $40^{\circ}\text{C}$     (b) 60 g  $\text{KNO}_3$ /100 mL  $\text{H}_2\text{O}$  at  $50^{\circ}\text{C}$
- Do the solubilities of all ionic solids increase as the temperature increases?
- How does the solubility of a gas change with increasing temperature? Draw a rough sketch showing the general shape of a solubility curve of a gas.